

WHAT IS CLAIMED IS:

1                   1.       A method of inhibiting an induced aberration resulting from refractive  
2 surgery, the method comprising:  
3                   (a)     inputting a target optical surface shape;  
4                   (b)     determining a model optical surface shape based on the target optical  
5 surface shape and a set of refractive surgery system parameters;  
6                   (c)     comparing the target optical surface shape and the model optical  
7 surface shape to determine an aberration induced by the set of refractive surgery system  
8 parameters; and  
9                   (d)     adjusting the set of refractive surgery system parameters so as to  
10 inhibit the induced aberration.

1                   2.       The method of claim 1, wherein the set of refractive surgery system  
2 parameters comprises at least one member selected from the group consisting of a wavefront  
3 device variable, a laser ablation profile variable, a laser registration and tracking system  
4 variable, a microkeratome variable, and a healing effect variable.

1                   3.       The method of claim 1, wherein the adjustment of the set of refractive  
2 surgery system parameters is based on a metric selected from the group consisting of an  
3 accuracy variable, a heating variable, and a treatment time variable.

1                   4.       The method of claim 3, wherein the accuracy variable is based on a  
2 root mean squares error factor.

1                   5.       The method of claim 3, wherein the heating variable is based on a  
2 temperature factor.

1                   6.       The method of claim 3, wherein the treatment time variable is based on  
2 an ablation time factor.

1                   7.       The method of claim 1, wherein the aberration comprises a high order  
2 aberration.

1                   8.       The method of claim 1, wherein the target optical surface shape is  
2 configured to address a low order aberration.

1                   9.       The method of claim 2, wherein the wavefront device variable  
2 comprises a member selected from the group consisting of a spot identification factor, an  
3 accommodation factor, and a reconstruction factor.

1                   10.     The method of claim 9, wherein the reconstruction factor comprises a  
2 member selected from a group consisting of uncompensated residual error portion, a  
3 measurement error portion, and a remaining error portion.

1                   11.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a member selected from the group consisting of a pulse size factor, a spot size  
3 variability factor, a beam uniformity factor, and a laser pulse repetition rate factor.

1                   12.     The method of claim 2, wherein the microkeratome variable comprises  
2 a member selected from the group consisting of a central flattening and peripheral thickening  
3 effect factor and a hinge effect factor.

1                   13.     The method of claim 2, wherein the laser registration and tracking  
2 system variable comprises a member selected from the group consisting of a registration  
3 factor, a linear tracking factor, and a torsional tracking factor.

1                   14.     The method of claim 2, wherein the wavefront device variable is  
2 configured to address a high order aberration.

1                   15.     The method of claim 2, wherein the wavefront device variable  
2 comprises a gridsize factor adjusted to about 100  $\mu\text{m}$ , and the laser ablation profile variable  
3 comprises a flying spot scanning factor adjusted to range from about 1 mm to about 1.6 mm.

1                   16.     The method of claim 15, wherein the flying spot scanning factor is  
2 adjusted to about 1.5 mm.

1                   17.     The method of claim 2, wherein the wavefront device variable  
2 comprises a spot identification error adjusted to about 0.05 microns.

1                   18.     The method of claim 2, wherein the wavefront device variable  
2 comprises a wavefront reconstruction error adjusted to about 0.05 microns.

1                    19.     The method of claim 2, wherein the wavefront device variable  
2 comprises an accommodation error adjusted to about 0.25D, equivalent to about 0.325  
3 microns RMS error for an approximately 6mm pupil.

1                    20.     The method of claim 2, wherein the microkeratome variable comprises  
2 an induced positive spherical aberration adjusted to between about 0.1 microns and about 0.3  
3 microns.

1                    21.     The method of claim 2, wherein the microkeratome variable comprises  
2 a coma in the direction of the microkeratome hinge adjusted to between 0.1 microns and 0.3  
3 microns.

1                    22.     The method of claim 2, wherein the healing effect variable comprises a  
2 Gaussian kernel adjusted to about 2 micron in height and about 0.5mm in full width at half  
3 maximum (FWHM).

1                    23.     The method of claim 1 wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS of about 0.3  $\mu\text{m}$  is  
3 achieved.

1                    24.     The method of claim 23, wherein a pre-operative total high order RMS  
2 is about 0.3  $\mu\text{m}$ .

1                    25.     The method of claim 23, wherein each component of the total high  
2 order RMS does not exceed about 0.113  $\mu\text{m}$ .

1                    26.     The method of claim 1, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS of about 0.1  $\mu\text{m}$  is  
3 achieved.

1                    27.     The method of claim 26, wherein a pre-operative total high order RMS  
2 is about 0.3  $\mu\text{m}$ .

1                    28.     The method of claim 26, wherein each component of the total high  
2 order RMS does not exceed about 0.038  $\mu\text{m}$ .

1                   29.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a registration accuracy adjusted to less than about 10  $\mu\text{m}$  in both the  
4 vertical and horizontal directions and a rotational error adjusted to less than about 0.5°.

1                   30.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a registration accuracy adjusted to less than about 10  $\mu\text{m}$  in both the  
4 vertical and horizontal directions and a rotational error adjusted to less than about 0.5°.

1                   31.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a tracking accuracy adjusted to less than about 20  $\mu\text{m}$  in both the vertical  
4 and horizontal directions, a latency time adjusted to less than about 10 ms, and a tracking  
5 speed adjusted to about 60 Hz or greater.

1                   32.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a tracking accuracy adjusted to less than about 5  $\mu\text{m}$  in both the vertical  
4 and horizontal directions, a latency time adjusted to less than 5 ms, and a tracking speed  
5 adjusted to about 200 Hz or greater.

1                   33.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a cyclo-torsional tracking angular accuracy adjusted to 0.5° or better.

1                   34.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a cyclo-torsional tracking angular accuracy adjusted to 0.25° or better.

1                   35.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a laser energy fluctuation adjusted to less than 4%.

1                   36.     The method of claim 2, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a laser energy fluctuation adjusted to less than 2%.

1                   37.     The method of claim 2, wherein the target optical surface shape  
2 comprises a set of 6-order Zernike polynomials, and the set of refractive surgery system  
3 parameters is adjusted such that each component of a post-operative total high order RMS  
4 does not exceed about 0.022  $\mu\text{m}$ .

1                   38.     The method of claim 2, wherein the target optical surface shape  
2 comprises a set of 6-order Zernike polynomials, and the set of refractive surgery system  
3 parameters is adjusted such that each component of a post-operative total high order RMS  
4 does not exceed about 0.0073  $\mu\text{m}$ .

1                   39.     The method of claim 1, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS is substantially  
3 equivalent to a pre-operative total high order RMS.

1                   40.     The method of claim 1, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS is less than a  
3 pre-operative total high order RMS.

1                   41.     The method of claim 1, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS is about one third the  
3 amount of a pre-operative total high order RMS.

1                   42.     A method of altering aberration distribution resulting from optical  
2 surface refractive surgery, the method comprising:

- 3                   (a)     inputting a target optical surface shape;
- 4                   (b)     determining a model optical surface shape based on the target optical  
5 surface shape and a set of refractive surgery system parameters;
- 6                   (c)     comparing the target optical surface shape and the model optical  
7 surface shape to determine an aberration distribution; and
- 8                   (d)     adjusting the set of refractive surgery system parameters so as to alter  
9 the aberration distribution.

1                   43.     A method of inhibiting a refractive surgery induced aberration, the  
2 method comprising:

- 3                   (a)     inputting a target optical surface shape;  
4                   (b)     determining a model optical surface shape based on the target optical  
5 surface shape and a set of refractive surgery system parameters, the model optical surface  
6 shape having an aberration; and  
7                   (c)     adjusting the set of refractive surgery system parameters so as to  
8 inhibit the aberration.

1                   44.     A system for inhibiting an induced aberration resulting from refractive  
2 surgery, the system comprising:

- 3                   (a)     an input that accepts a target optical surface shape;  
4                   (b)     a module that determines a model optical surface shape based on the  
5 target optical surface shape and a set of refractive surgery system parameters; and  
6                   (c)     a module that adjusts the set of refractive surgery system parameters so  
7 as to inhibit an aberration in the model optical surface shape.

1                   45.     The system of claim 44, wherein the set of refractive surgery system  
2 parameters comprises at least one member selected from the group consisting of a wavefront  
3 device variable, a laser ablation profile variable, a laser registration and tracking system  
4 variable, a microkeratome variable, and a healing effect variable.

1                   46.     The system of claim 44, wherein the module that adjusts the refractive  
2 surgery system parameters comprises a metric selected from the group consisting of an  
3 accuracy variable, a heating variable, and a treatment time variable.

1                   47.     The system of claim 46, wherein the accuracy variable is based on a  
2 root mean squares error factor.

1                   48.     The system of claim 46, wherein the heating variable is based on a  
2 temperature factor.

1                   49.     The system of claim 46, wherein the treatment time variable is based  
2 on an ablation time factor.

1                   50.     The system of claim 44, wherein the aberration comprises a high order  
2 aberration.

1                   51.     The system of claim 44, wherein the target optical surface shape is  
2 configured to address a low order aberration.

1                   52.     The system of claim 45, wherein the wavefront device variable  
2 comprises a member selected from a group consisting of a spot identification factor, an  
3 accommodation factor, and a reconstruction factor.

1                   53.     The system of claim 52, wherein the reconstruction factor comprises a  
2 member selected from the group consisting of uncompensated residual error portion, a  
3 measurement error portion, and a remaining error portion.

1                   54.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a member selected from the group consisting of a pulse size factor, a spot size  
3 variability factor, a beam uniformity factor, and a laser pulse repetition rate factor.

1                   55.     The system of claim 45, wherein the microkeratome variable  
2 comprises a member selected from the group consisting of a central flattening and peripheral  
3 thickening effect factor and a hinge effect factor.

1                   56.     The system of claim 45, wherein the laser registration and tracking  
2 system variable comprises a member selected from the group consisting of a registration  
3 factor, a linear tracking factor, and a torsional tracking factor.

1                   57.     The system of claim 45, wherein the wavefront device variable is  
2 configured to address a high order aberration.

1                   58.     The system of claim 45, wherein the wavefront device variable  
2 comprises a gridsize factor adjusted to about 100  $\mu\text{m}$ , and the laser ablation profile variable  
3 comprises a flying spot scanning factor adjusted to range from about 1 mm to about 1.6 mm.

1                   59.     The system of claim 58, wherein the flying spot scanning factor is  
2 about 1.5 mm.

1                   60.     The system of claim 45, wherein the wavefront device variable  
2 comprises a spot identification error adjusted to about 0.05 microns.

1                   61.     The system of claim 45, wherein the wavefront device variable  
2 comprises a wavefront reconstruction error adjusted to about 0.05 microns.

1                   62.     The system of claim 45, wherein the wavefront device variable  
2 comprises an accommodation error adjusted to about 0.25D, equivalent to 0.325 microns  
3 RMS error for a 6mm pupil.

1                   63.     The system of claim 45, wherein the microkeratome variable  
2 comprises an induced positive spherical aberration adjusted to between about 0.1 microns and  
3 about 0.3 microns.

1                   64.     The system of claim 45, wherein the microkeratome variable  
2 comprises a coma in the direction of the microkeratome hinge adjusted to an amount between  
3 0.1 microns and 0.3 microns.

1                   65.     The system of claim 45, wherein the healing effect variable comprises  
2 a Gaussian kernel adjusted to about 2 micron in height and about 0.5mm in full width at half  
3 maximum (FWHM).

1                   66.     The system of claim 44 wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS of about 0.3  $\mu\text{m}$  is  
3 achieved.

1                   67.     The system of claim 66, wherein a pre-operative total high order RMS  
2 is about 0.3  $\mu\text{m}$ .

1                   68.     The system of claim 66, wherein each component of the total high  
2 order RMS does not exceed about 0.13  $\mu\text{m}$ .

1                   69.     The system of claim 44, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS of about 0.1  $\mu\text{m}$  is  
3 achieved.



1                   70.     The system of claim 69, wherein a pre-operative total high order RMS  
2 is about 0.3  $\mu\text{m}$ .

1                   71.     The system of claim 69, wherein each component of the total high  
2 order RMS does not exceed about 0.045  $\mu\text{m}$ .

1                   72.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a registration accuracy adjusted to less than 10  $\mu\text{m}$  in both the vertical and  
4 horizontal directions and a rotational error adjusted to less than 0.5°.

1                   73.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a registration accuracy adjusted to less than 10  $\mu\text{m}$  in both the vertical and  
4 horizontal directions and a rotational error adjusted to less than 0.5°.

1                   74.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a tracking accuracy adjusted to less than 20  $\mu\text{m}$  in both the vertical and  
4 horizontal directions, a latency time adjusted to less than 10 ms, and a tracking speed  
5 adjusted to 60 Hz or greater.

1                   75.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a tracking accuracy adjusted to less than 5  $\mu\text{m}$  in both the vertical and  
4 horizontal directions, a latency time adjusted to less than 5 ms, and a tracking speed adjusted  
5 to 200 Hz or greater.

1                   76.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a cyclo-torsional tracking angular accuracy adjusted to 0.5° or better.

1                   77.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a cyclo-torsional tracking angular accuracy adjusted to 0.25° or better.

1                   78.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a variable spot scanning factor, and the laser registration and tracking system  
3 variable comprises a laser energy fluctuation adjusted to less than 4%.

1                   79.     The system of claim 45, wherein the laser ablation profile variable  
2 comprises a flying spot scanning factor, and the laser registration and tracking system  
3 variable comprises a laser energy fluctuation adjusted to less than 2%.

1                   80.     The system of claim 45, wherein the target optical surface shape  
2 comprises a set of 6-order Zernike polynomials, and the set of refractive surgery system  
3 parameters is adjusted such that each component of a post-operative total high order RMS  
4 does not exceed about 0.025  $\mu\text{m}$ .

1                   81.     The system of claim 45, wherein the target optical surface shape  
2 comprises a set of 6-order Zernike polynomials, and the set of refractive surgery system  
3 parameters is adjusted such that each component of a post-operative total high order RMS  
4 does not exceed about 0.0087  $\mu\text{m}$ .

1                   82.     The system of claim 44, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS is substantially  
3 equivalent to a pre-operative total high order RMS.

1                   83.     The system of claim 44, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS is less than a  
3 pre-operative total high order RMS.

1                   84.     The system of claim 44, wherein the set of refractive surgery system  
2 parameters is adjusted such that a post-operative total high order RMS is about one third the  
3 amount of a pre-operative total high order RMS.